Sustainable Intensification: Agroecological Appropriation or Contestation?

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Sustainable Intensification: Agroecological Appropriation or Contestation?

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Abstract
For at least the past decade, global institutions have been promoting sustainable intensification (SI) to raise yields with less environmental harm through a broad 'toolkit' including agroecological methods. In the European context, agri-intensification has diverse forms and policy agendas. SI has been advocated to help keep farmers on the land by making their cultivation methods more market-competitive, while conserving biodiversity elsewhere; this approach complements a land-sparing strategy. By contrast, a different intensification agenda promotes biodiverse agroecosystems, complementing a land-sharing strategy. The latter corresponds with an alliance of farmers and civil society organisations (CSOs) promoting agroecology to transform the dominant agro-food regime. In their efforts towards supportive policies, such alliances have gained larger budgets for agroecological methods in the EU's R&D programmes. But their efforts at 'greening the CAP' have resulted in rules which still subsidise higher-yield practices without necessarily benefiting agri-biodiversity. By recognising these tensions, practitioners can better develop strategies for intervening in various agri-policy arenas, even where SI remains implicit.

Introduction

Since at least the 1980s 'sustainable agriculture' has been a contested term, encompassing divergent aims and policy agendas (Buttel, 2006; Carolan, 2006; Clapp and Fuchs, 2009; Constance, 2010; Douglass, 1984; Kloppenburg, 1988; Lélé, 1991; Marletto et al., 2016). In the past decade, an extra focus has been agri-intensification, especially around the concept 'sustainable intensification'. Such debate intersects with a contest over how agroecology relates to the dominant agro-food regime (Giraldo and Rosset, 2017; Levidow et al., 2014).

This article analyzes how sustainable intensification (henceforth SI) has been promoted in the European context, through the following questions:
How do agri-intensification agendas appropriate agroecological practices for reinforcing the dominant agro-food system? or else for contesting it?
How do such issues arise in various policy arenas? through what alliances and agendas?

As a basis to address those questions, the next section introduces theoretical concepts on the incumbent food regime – its agents, its reform agenda and its contestation. Later sections analyse the following: the global drivers and debate on SI; intensification priorities, means and trade-offs; European farmers' agendas and their conflicting role in policy arenas, especially for agri-research and subsidy criteria. The Conclusion returns to the above questions.

1 Food regime contested: theoretical concepts

'Sustainability' has a long, contested history, especially in agriculture. Conventional agriculture has often renewed its capacity for 'sustaining the unsustainable', e.g. promoting GM crops as more sustainable than conventional agriculture (Buttel, 2005, 2006). Various techno-fixes, each promoting specific agri-futures, have been targets of controversy. To analyse the recent debates over SI, this section introduces several theoretical concepts: neoproductivism, a market-driven food regime (with a reform trend), and a corporate-environmental food regime.

Since the 2007-08 spike in food prices, global institutions have promoted greater agricultural productivity. With an imperative to double food production by 2050, this dominant agenda conflates people's needs, marketing strategies and 'demand' for much greater meat consumption (e.g. FAO, 2009a). Proponents have highlighted long-term difficulties: higher energy costs, competing land uses, GHG emissions, resource burdens and other environmental harms.

That agenda has recast agro-industrial productivism: an incipient neo-productivist paradigm faces the challenge to locate the environmental sustainability and resilience of national food-supply systems within current globalisation patterns (Marsden, 2012: 307). Neoproductivism has been repositioned in different ways across national political systems (Almas and Campbell, 2012). Although it encompasses a cooperative version enhancing farmers' knowledge, the prevalent form is a competitive market-driven productivism (Burton and Wilson, 2012). The neoproductivist agenda has been widely articulated as 'sustainable intensification'. With its diverse meanings, this shift can be analyzed through political economy theories of the agro-food system as a global regime.

A food regime has been theorised as a 'rule-governed structure of production and consumption of food'. Since the 1990s the dominant agro-food regime has been widely called 'free trade', a misnomer for the GATT-WTO agreements overcoming or deterring trade barriers. In this market-driven system, agro-industrial methods maximise yield and generate surpluses, for which subsidy gains global export. This undermines productive capacities and less-intensive methods elsewhere, thus pushing farms everywhere to adopt intensification methods. In this dominant regime, 'agrofood corporations are the major agents attempting to regulate agrofood conditions, that is, to organize stable conditions of production and consumption which allow them to plan investment,

sourcing of agricultural raw materials, and marketing' (Friedmann, 2003: 52). This regime rests on assumptions that international trade more efficiently accommodates food needs; this has become normalized, even 'as a key delivery mechanism for food system sustainability' (Clapp, 2017).

The dominant regime has faced global resistance from small-scale food producers. Launched by Via Campesina at the 1996 World Food Summit, 'food sovereignty' has since been taken up by numerous farmers' and civil society organizations, while also contesting the capital-intensive agri-modernization project. Over the past decade such groups have jointly linked food sovereignty with agroecology as a transformative agenda (Holt-Gimenez and Shattuck, 2011). Such a role depends on linking the three main forms of agroecology – a scientific discipline, an agricultural practice and a social movement (Wezel et al., 2009).

Partly in response to such resistance, mainstream institutions have been promoting changes such as more public finance for agri-development, third-party certification and product labelling to address weak sustainability, and higher-productivity cultivation methods for market competitiveness (e.g. UN, 2008, cited above). Together these changes have been theorised as a 'reformist' model, meant to integrate smallholders into global markets, often in the name of social inclusion and environmental sustainability. Facing global revolts against agbiotech, the reformist model accepts that addressing global hunger needs all possible solutions, while narrowing these to various techniques (Holt-Gimenez and Shattuck, 2011: 121-23).

Meanwhile counter-hegemonic global food movements contest the corporate food regime and its productivist agenda. These movements embrace agroecology and community-based food systems but vary in political perspectives, which may co-exist in the same organisation. The 'progressive' trend promotes alternatives to agro-industrial foods, implicitly accepting the dominant regime, while the 'radical' trend seeks to confront it explicitly through an agenda for food sovereignty. Each trend is heterogeneous and politically fluid. The current food crisis offers opportunities for strategic alliances between them, but also opportunities for the reformist agenda to split the progressive from the radical trend (Holt-Gimenez and Shattuck, 2011: 133-34).

Indeed, for a long time capitalism has had success in co-opting resistance, especially in the the global North. Its socially articulated nation-states seek to maintain a complementarity between the role of the labour force as producers and consumers, in turn as a basis for legitimacy. Here the 'progressive' trend encompasses small-farm petty commodity producers and domestic agri-business facing threats to their local markets by globalized circuits of corporate agri-food capital (Tilzey, 2017: 23).

As the dominant regime responds to protest and new market opportunities, an overall trend has been theorised as a 'corporate-environmental food regime'. This shifts agro-industrial production methods towards reducing some harmful environmental effects, deepening commodity relations in agriculture, and fulfilling consumer demand for 'green' products. Such a new regime (or variant) potentially emerges from capitalising such alternatives: 'a new round of accumulation appears to be emerging in the agrofood sector, based on selective appropriation of demands by environmental movements, and including issues pressed by fair trade, consumer health, and animal welfare activists' (Friedmann, 2005: 229, 249).

In this nascent regime, some new standards originate from alternatives to the corporate-industrial regime, e.g. organic food and functional foods. But most health, environmental and social problems cannot be reduced to consumer demand for novel products. So a nascent corporate-environmental food regime has been contested by the alternative food movements that it appropriates (ibid: 257).

Given those regime shifts and conflicts, what are possible outcomes? For regimes in general, alternatives have been theorised as niche innovations, which can either fit-and-conform to the incumbent regime or else stretch-and-transform it (Smith and Raven, 2012: 1030). Any arena is more conducive to one strategy or the other. The two strategies are 'exercised in contrasting arenas, with potentially very different outcomes in terms of form and function of the emerging socio-technical system, who holds control and what sustainability criteria are maintained' (ibid: 1033). For the European debate, next let us examine different priorities of intensification, and then how stakeholder groups promote them.

2 Sustainable intensification (SI): global drivers and debate

The 'sustainable intensification' (henceforth SI) concept originally addressed problems of African smallholders. Attempting to maintain livelihoods and local food supplies, they face pressures to over-exploit the soil and/or to take over more land for cultivation. Such efforts could worsen environmental degradation. To enhance the resource base and livelihoods together, knowledge-based agroecological methods should conserve soil and water, as well as manage nutrient flows and pests. Through SI as participatory improvement methods, 'yields are increased without adverse environmental impact and without the cultivation of more land' (Pretty, 1997).

Intensification was given different priorities a decade later, especially after the 2007 increase in global food prices, signalling a longer-term global threat of food insecurity. This has been attributed to various causes – climate change (environmental stresses including pests and water scarcity), land and water shortages, competition for biomass, growing market demand for biofuels and livestock products, etc. (Conway, 2009). Such 'causes' ideologically naturalise global market forces as objective imperatives which must be accommodated through higher yields. Towards remedies, this intensification agenda conflates higher productivity, yields, better livelihoods, global market competitiveness and food security. A similar agenda has been widely taken up by mainstream institutions, aiming to integrate some peasants into the neoliberal food regime (Escobar, 2011).

For this agenda, a key UN document was the *Comprehensive Framework for Action* (CFA). It recognises that smallholder farmers are central to the long-term problems of hunger and poverty. Its agenda assumes that smallholders will benefit from 'expansion of agricultural marketing and processing enterprises which integrate smallholders into domestic and international food supply chains' (UN, 2008: 16, 28).

According to the *CFA*, the 'resilience and sustainability of agriculture under intensification' can be ensured through various techniques such as biotech and Conservation Agriculture. The latter is 'sometimes called agro-ecology because it combines agricultural practice and effective use of ecological knowledge and direct seeding into crop residues'. Conservation Agriculture features crop rotation as a means of energy efficiency and Integrated Pest Management. Public-Private Partnerships would help 'in enabling greater smallholder participation in market-oriented food production', e.g. by ensuring that any problems are trackable and that produce is traceable through the whole chain back to the producers (UN, 2008: 26, 30).

How to reconcile higher yield with sustainability? For the UK's Royal Society, sustainable intensification (SI) production systems are 'knowledge-, technology-, natural capital- and land-intensive'. To avoid environmental damage, the 'intensity of use of non-renewable inputs must in the long term decrease' by substituting various techniques including agroecology and GM crops (Royal Society, 2009: 46), thus very broadly defining 'renewable' inputs. This imperative is linked with globalised, volatile markets: 'Domestic patterns of food production and consumption have become interconnected in global markets' (ibid: 4). In those ways, SI agendas promote a 'toolkit' of various options for reconciling higher productivity with environmental sustainability, especially for a competitive advantage in commodity markets.

Exemplifying SI, Conservation Agriculture promotes no-till methods to conserve soil fertility and avoid erosion. Alternatives to tillage include treatments with total herbicides (e.g. Syngenta, 2013), sometimes with herbicide-tolerant crops, all in the name of sustainable intensification. Along those lines, some agri-input supply companies have rebranded their products as SI tools (Constance and Moseley, 2018).

The UN's Food and Agriculture Organisation (FAO) has promoted SI for crop production. Its agenda 'allows countries to achieve sustainable increases in agricultural productivity through an ecosystem approach', especially for going beyond subsistence agriculture. The FAO emphasises wider market access, i.e. farmers competing on global markets:

> Increasing agricultural productivity through improved use of resources to achieve higher yields while promoting the sustainability of the farming systems and progressing from subsistence farming to market-oriented agriculture, supported by Conservation Agriculture (CA) and Integrated Plant Nutrient Management (IPNM)….
>
> Strengthening livelihoods using the benefits of increased productivity and diversification within the value chain, including through providing the conditions for access to good agricultural practices and knowledge, quality seeds, post-harvest and agro-processing technologies, food safety systems, markets and credit (FAO, n.d.).

This narrowly defines the objective as food products, while potentially aggravating farmers' dependence on input suppliers and market intermediaries.

Given that higher-yield methods often have negative impacts, SI agendas propose various technical remedies. There is a pervasive imperative to 'rebuild research and technology transfer capacity in developing countries in order to provide farmers with appropriate technologies', through 'a rich toolkit of relevant, adoptable and adaptable ecosystem-based practices' (FAO, 2011; cf. FAO, 2009: 31). Such a toolkit needs 'every possible solution, including agroecology and biotechnologies' (FAO, 2016a).

'Transfer' implies that Southern farmers adopt Northern innovations. Indeed, SI has been promoted as standard technology packages, generally inappropriate for diverse conditions. Any successful SI approach would need to understand relationships between smallholders, their organisations, other stakeholders and policies (Arora, and Nijbroek, 2016).

From the perspective of farmer-civil society alliances, the SI agenda acknowledges the potential contribution from agroecological methods, yet these are readily subordinated to the dominant agro-food system. The SI agenda neglects issues of procedural and distributive justice, e.g. collective empowerment to define needs and how they are met; this could strengthen agroecosystem approaches (Loos et al., 2014). Indeed, from the standpoint of food sovereignty, a global smallholder alliance warns against 'the threat of co-optation': agroecology is being appropriated 'as a set of production techniques that can conform to the industrial agriculture model', and thus as 'a tool to legitimize, sustain and replicate the dominant model' (IFA, 2015: 22).

This threat was likewise identified by La Via Campesina.

> … agroecology itself is under dispute by corporations, governments and the World Bank, with the scientists and intellectuals who knowingly or unwittingly work for them. This neoliberal attempt to co-opt agroecology can be seen in government 'organic agriculture' programs that promote monoculture-based organic exports for niche markets, and subsidize companies to produce organic inputs that are even more expensive than the agrotoxics whose costs led to the debt-trap so many rural families find themselves in (LVC, 2013: 70).

The food sovereigny movement says likewise: 'In this scenario we can see how green capitalism has "discovered" agroecology as a way of incorporating peasant agriculture, its territories and agro-ecological practices into global circuits of accumulation' (Nyeleni, 2016: 3).

Thus SI agendas provoke debate on several issues. Is the aim to 'feed the world sustainably' or rather to 'help the world feed itself' in socially just ways? How to compare the productivity of conventional and agroecological methods? Is the aim simply to make the former less harmful? How to enhance and evaluate entire agroecosystems? (Bernard and Lux, 2017). Such questions arise in distinctive ways in Europe – the focus of subsequent sections.

3 European debates on agri-intensification: priorities and trade-offs

As a distinctive context, European agriculture has been the focus of debates over divergent aims, e.g. intensification versus extensification, land-sparing versus land sharing, and 'feeding the world' versus feeding itself in more sustainable ways. In this context, expert reports provide entry points to analyze divergent forms and priorities of intensification.

3.1 Which intensification?

There has been a long-standing debate about how to intensify or ecologise agriculture, each agenda drawing on a different concept of ecology (Ollivier and Bellon, 2013). Agroecologists have promoted farm redesign around agroecosystems, whereby biodiversity provides various ecological services beyond producing food. Such services include: recycling nutrients, regulating microclimate and local hydrological processes, suppressing undesirable organisms and detoxifying noxious chemicals (Altieri, 1999). By contrast, an 'ecoagriculture' agenda has demarcated ecologically intensified areas from nature conservation areas, which are thereby spared from biodiversity loss.

Conflict between those two agendas erupted at the 2004 meeting of the International Union for the Conservation of Nature (IUCN). From an agroecological standpoint, the ecoagriculture agenda was attacked for a production model which 'hinders attempts to provide adequate food for a growing world population' (Altieri, 2004). In more subtle ways, an analogous conflict emerged later between agendas for land-sparing versus land-sharing (see later section).

To clarify those issues, a European multi-stakeholder initiative elaborated the new concept 'eco-functional intensification'. It means

> more efficient use of natural resources, improved nutrient recycling techniques and agro-ecological methods for enhancing diversity and the health of soils, crops and livestock. Such intensification builds on the knowledge of stakeholders using participatory methods… [It means] activating more knowledge and achieving a higher degree of organization per land unit. It intensifies the beneficial effects of ecosystem functions, including biodiversity, soil fertility and homeostasis (Niggli et al, 2008: 34).

Originating from the organic sector, this concept was eventually promoted as agroecological, with broader relevance for improving all agriculture (ARC2020 et al., 2012; Bellon, 2016).

Eco-functional intensification emphasises resource conservation and recycling, towards lower dependence on external inputs:

> Diversified land use can open up new possibilities for combining food production with biomass production and on-farm production of renewable energy from livestock manure, small biotopes, perennial crops and semi-natural non-cultivated areas. Semi-natural grasslands may be conserved and integrated in stockless farm operations by harvesting biomass for agro/bio-energy and recapturing nutrients from residual effluent for use as supplementary organic fertiliser on cultivated land (Schmid et al., 2009: 26).

For example, spatial crop diversification encompasses intercropping annual grain species, cultivar mixes, perennial grains, or forage species and forestry and annual crops. For greatest success, such methods would depend on changes in plant breeding, agricultural extension services and marketing (Jensen, 2015).

In those ways, eco-functional intensification has overlaps with the earlier concept 'ecological intensification'. Initially it meant more precise, efficient use of external inputs for commodity crops (Cassman, 1999). Later it acquired agroecological meanings, i.e. mimicking and incorporating natural ecological interactions to intensify productivity. Thus the concept has meant 'intensification in the use of the natural functionalities that ecosystems offer' (Chevassus au Louis and Griffon, 2008).

Seen as a set of techniques, 'ecological intensification' has trade-offs between several aims – productivity versus resilience, biodiversity, ecosystem services, etc. But those aims have potential synergies, depending on agroecosystem design (Geertsema et al, 2016). There is debate on the aims of agroecological practices – for merely incremental improvement or else transformational change (Brym and Reeve, 2016: 214).

The full potential depends on wider agroecosystems beyond the farm:

> New avenues for agronomy to strengthen agroecological intensification should go beyond the cultivated field or the mixture of species in a given landscape. They should explore desirable properties and mechanisms that operate at the scale of complex socio-ecological systems, i.e. that take into account sociological and ecological dynamics and interactions in agroecosystems (Doré et al., 2011: 203).

Ecological intensification emphasises ecological processes and ecosystem services. These depend on stakeholder involvement to strengthen practitioners' knowledge of such processes (Wezel et al., 2015).

Those diverse meanings and aims have entered debates on sustainable intensification (SI). According to participants at a UK multi-stakeholder workshop, SI encompasses various biotechnological, agroecological and other methods – meant to increase yield, while also lowering the burdens on land use and natural resources. The workshop report elaborated ways to link SI with an agroecosystem approach, central to agroecology (Garnett, and Godfray, 2012). But the latter's advocates remain doubtful about its prospects within SI. From the Soil Association, promoting organic certification, one participant described his experience of SI agendas as follows:

> … for unquestioning investment in developing new agricultural inputs instead of a greater focus on agroecology; for a less caring approach to animal welfare or biodiversity in the name of upping production; for a narrow definition of sustainability that leaves little room for fairness, health or changes in consumption practices. In effect, for agribusiness as usual with a light green tinge (Tom Macmillan, ibid: 41).

Indeed, SI easily becomes a proxy for techno-fixes. At a Royal Society meeting on sustainable intensification, all five speakers emphasised the imperative to increase yields, in turn as an imperative for GM crops. As a commentator reported sarcastically: 'In their minds, only GM has the potential to solve all the world's food problems and be kinder to the environment and wildlife at the same time'. Instead 'we need to put much more of our effort into improving agriculture in ways we can be sure won't actually make food production less sustainable' (Young, 2013).

Techno-fixes also complement biodiversity protection through land-sparing rather than land-sharing. The former has been the dominant policy agenda, favoured by major interests such as the European Crop Protection Association and the European Landowners Organisation. According to their joint briefing on agri-biodiversity, 'the loss of ecological heterogeneity as a consequence of agricultural intensification and landscape homogenisation has had negative impacts on other bird species' (ELO & ECPA, 2009: 26). From their standpoint, however, modern agricultural technologies have raised yields and can do so more sustainably on existing agricultural land. Such improvements minimise demand for land, thus leaving more available for biodiversity conservation (ibid.). This implicitly supports land-sparing, rather than land-sharing through broader agroecosystems (EP, 2016: 7; Green et al., 2005). Such policy conflicts underlie divergent forms and aims and intensification.

Relevance to that debate depends on different ways of framing 'productivity'. As a flexible output/input ratio, this can be interpreted in multiple ways, as a basis for framing trade-offs between productivity versus biodiversity. Next let us examine two expert reports exploring trade-offs in a European agricultural context

3.2 Minimising trade-offs through land-sparing?

A high-profile report on SI has come from the Rural Investment Support for Europe (RISE) Foundation, chaired by Franz Fischler, the former EU Commissioner for Agriculture (Buckwell et al., 2014: 95). The study was funded partly by the European Landowners Organisation (ibid: 95). Some affiliates seek to reserve non-cultivated land for lucrative recreational purposes such as game-hunting, consistent with a land-sparing policy (cf. ELO & ECPA, 2009 above),.

According to the RISE report, Europe's main agricultural problem is land abandonment, alongside unsustainable intensification and rising food imports:

> Agricultural encroachment onto new lands is not the problem in the EU; indeed the reverse process of agricultural abandonment is more often of concern for environmental and social reasons. The critical EU issue is that the past intensification of agriculture is associated with pervasive undesirable environmental impacts in Europe. An additional concern is that agricultural imports into the EU are associated with environmental damage in the exporting countries (Buckwell et al., 2014: 7).

This problem-diagnosis informs the report's rationale for SI, namely: Further increments in global food output must come largely from higher yields on existing agricultural land, e.g. as a means to substitute for imports. Sustainability aspects need most attention in Europe, which anyway cannot feed the world and should reduce its dependence on imports. How?

Towards improvements, the key concept is defined as follows: 'Sustainable Intensification means simultaneously improving the productivity and environmental management of agricultural land...' Productivity is attributed different meanings: 'A sustainable intensification path could mean an increase in the output per hectare of environmental services of the farm or an increase in agricultural products per hectare; it does not only mean the latter' (Buckwell et al., 2014: 7, 76). Broader than yield alone, productivity can encompass those public goods.

Agricultural strategies have various trade-offs, as depicted in the diagram. Generally intensification 'involves some reduction in environmental performance in exchange for increased food production, but staying in the sustainable quadrant. In the past, production choices have led to sacrifice of some environment for food output' (Buckwell et al., 2014: 17). The latter appears where the black curve moves downwards, denoting loss of plant species.

From the large dot, arrows towards the black curve indicate familiar trade-offs, stereotypically known as intensification versus extensification. By contrast, vertical and horizontal arrows towards the biodiversity-yield frontier bound the 'sustainable quadrant'. This encompasses various methods which maintain or increase biodiversity, while also potentially increasing yield (Buckwell et al., 2014: 70).

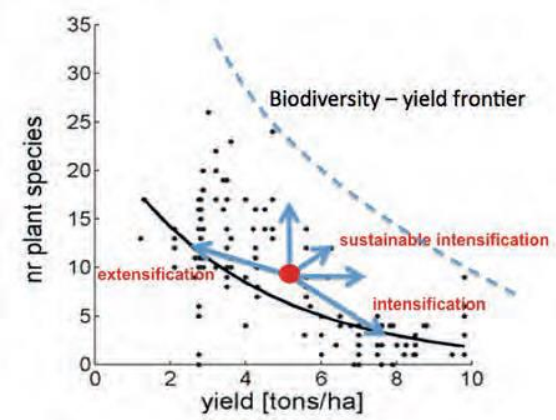

Figure 1**:** Sustainable Intensification – biodiversity (Buckwell et al., 2014: 70).
Credit: by permission of the RISE Foundation.

How to reconcile those aims? The report mentions six sustainable systems: agroecology, biodynamic, organic, integrated, precision farming and conservation agriculture. To reduce chemical inputs, for example, these can be substituted through nutrient recycling (ibid: 65).

As a key message, protecting natural resources could mean withdrawing some land from cultivation: 'In this context the potential output loss from the further withdrawal of a few percentage points of land to provide biodiversity and water protection could be replaced by a relatively few years' productivity growth' (Buckwell et al., 2014: 55). Consistent with a land-sparing strategy, the report emphasises biodiversity as an environmental good – but not as agroecosystems, a crucial basis for agroecological methods to be effective through land-sharing.

For policy relevance, the report anticipates SI gaining impetus from agri-environmental and subsidy criteria of the EU's Common Agricultural Policy, especially its requirement for Ecological Focus Areas. However, that policy framework exemplifies conflicts around intensification (see penultimate section).

3.3 Creating public goods through agroecosystems

To clarify preferable forms of SI, UK state agencies commissioned a report from the Land Use Policy Group (LUPG), who used the opportunity to promote agroecological methods. Looking beyond yield alone, the report defines productivity in terms of lower resource inputs and public goods. The report notes trade-offs of several kinds:

> Productivity also implies efficiency with respect to resources used (and their related emissions), which may involve a trade-off between yields per hectare and, for example, fossil energy use and GHG emissions per kg of food produced (Lampkin et al., 2015: 66).

As some farmers shift from agrochemical to agroecological methods, they replace external with internal inputs. There are still trade-offs between productivity versus biodiversity:

> In situations where there was a greater reduction in agrochemical use, and a greater uptake of practices such as reliance on biological nitrogen fixation and soil fertility-building phases in rotations, there was a trade-off involving reduced yields alongside an increased output of environmental goods and associated (non-provisioning) ecosystem services. Despite this, levels of efficiency (in terms of non-renewable resource use and emissions) were not necessarily any worse and often improved (Lampkin et al., 2015: 110).

This counts as advantageous by emphasising environmental goods, and broadly defining efficiency in terms of resource usage rather than yield per unit land.

The report warns against single-technique fixes, which can cause problems. Specific practices in isolation (e.g. bio-substitutes for fertilisers and pesticides) can undermine crop protection and yields.

> Sustainable intensification, if focused mainly on producing more with less, represents only the first step on the way. While some initiatives may encourage input substitution, for example replacing harmful pesticides with less harmful alternatives, this does not imply implementation of an agroecological approach (Lampkin et al., 2015: 10).

Towards the latter approach, combining suitable practices can generate synergistic relationships. Substituting for chemical fertilisers, legumes fix nitrogen; they also support pollinators, as well as improving the nutritional and health value of forage crops for livestock (Lampkin et al., 2015: 109).

A modest step, input substitution could stimulate a farmer to make greater changes towards agroecosystems: 'a system redesign approach based on ecological principles is considered more likely to get closer to a sustainable end point' (ibid). Such systems are 'knowledge-based rather than technology-intensive' (ibid: 108). Greatest benefits come from 'a whole-system redesign approach focused on the farm ecosystem', dependent on biodiversity beyond cultivated fields (cf. Altieri, 1999).

If an SI agenda emphasises greater provision of environmental goods and ecosystem services, then agroecology has a significant contribution. Likewise if productivity broadly encompasses public goods per unit resource input, rather than simply yield per unit land (see earlier). While the RISE report implicitly complements a strategy of land-sparing, the LUPG report advocates land-sharing (ibid: 92). This resonates with a wider agroecological agenda:

> A major argument for wildlife-friendly farming and agroecological intensification is that crucial ecosystem services are provided by 'planned' and 'associated' biodiversity, whereas the land sparing concept implies that biodiversity in agroecosystems is functionally negligible (Tscharntke *et al.* 2012; ibid).

What are the obstacles? Market signals incentivise higher yield. Moreover, UK institutions serving agriculture 'are resistant to changes in their worldview, with a continuing strong focus on technology-driven production increases...' (Lampkin et al., 2015: 116). Indeed, this could describe how SI selectively appropriates aspects of agroecological methods. Next let us look at European policy agendas for agri-intensification and their subsidy incentives.

4 EU policy tensions around agri-intensification

In the European Union, farmers' alliances promote different forms of innovation, especially in agendas for agri-innovation and for agri-subsidy. Both relate likewise to different forms of intensification. Let us examine these differences.

4.1 Stakeholders' divergent agri-innovation agendas

Europe's conventional farmers are represented politically by COPA-COGECA, promoting a neo-mercantilist export-orientated strategy as the main basis to continue subsidies under the Common Agricultural Policy or CAP (Potter and Tilzey, 2005). According to this lobby, 'To be able to satisfy the demand for sustainable intensification it is essential to have better conditions for more efficient use of water, fertilisers and other resources at farm level' (COPA-COGECA, 2012: 7). Here SI becomes an output-input efficiency for global market competitiveness, thus setting criteria for preferable agronomic techniques. Along these lines, many European farmers have sought to become more competitive by reducing external inputs.

By contrast, widespread agroecological initiatives in the global South have inspired similar efforts in Europe, where the ecological aspects have been articulated with socio-political ones (Stassart et al., 2012). According to a broad European alliance of farmers' and civil society groups: 'the solution lies in a high degree of self-sufficiency and food sovereignty at local, regional, national or continental level', where people have 'the right to establish their own agriculture and food

policy' (ARC2020, 2010). For the European affiliate of La Via Campesina, 'Agroecology as understood by social movements is complementary and inseparable from food sovereignty we want to build' (ECVC, 2013; also 2015).

In an EU policy context emphasising innovation, mainly meaning capital-intensive technology, agroecology has been promoted as a different kind of innovative practice. It combines four types of innovation – know-how, organisational, social and technological (IFOAM EU Group et al., 2012). This reverses the stereotype of experts transferring techniques to farmers. Agroecological methods have gained interest from conventional farmers facing a cost-price squeeze, potentially driving them off the land.

Agroecological perspectives have been incorporated into the EU's research priorities. When the Directorate-General for Research hosted expert foresight studies, these advocated agroecological approaches:

> Approaches that promise building blocks towards low-input high-output systems, integrate historical knowledge and agroecological principles that use nature's capacity and models nature's system flows, should receive the highest priority for funding (SCAR FEG, 2011: 8).

Since 2008 the EU organics lobby has been making detailed proposals for agroecological research topics (Niggli et al., 2008), with support from COPA-COGECA's Organics section. Many were adopted and funded in Framework Programme 7 (2007-14), eventually with the umbrella term 'eco-functional intensification'. This diverges from the productivist agenda of agri-industry (for detail, see Levidow et al., 2014). Both agendas were extended into the successor programme, Horizon 2020 (2014-2020).

Meanwhile, within their agenda for social justice and sustainability, civil society organisations have jointly promoted agroecology. This is 'based on applying ecological concepts and principles to optimize interactions between plants, animals, humans and the environment while taking into consideration the social aspects that need to be addressed for a sustainable and fair food system' (GHA, 2017: 5). This cites the FAO's agroecology initiative, whose European conference declared, 'Agroecology principles should be formulated and used as the principle guideline to transform and improve the current food system' (FAO, 2016b: 3). Civil society groups shaped its agroecology initiative, by contrast with the prevalent FAO agenda for a productivist intensification.

As another policy arena, the European Commission set up European Innovation Partnerships (EIP) in several sectors. The one for Agricultural Productivity and Sustainability had a High Level Steering Board representing diverse stakeholders, especially the agri-supply industry, as well as several CSOs allied with small-scale farmers' groups. Disagreements arose about what forms of productivity would be environmentally sustainable. Agri-industry representatives emphasised greater yield with less external inputs; by contrast, the CSO-farmer network emphasised environmental sustainability and biodiversity through practices enhancing farmers' knowledge (cf. ARC2020 et al., 2012).

The EIP-Agri's Strategic Implementation Plan encompassed all those approaches, e.g. organic farming, low-external input systems, sustainable intensification, etc. 'The diversity of knowledge (local / traditional know-how and practices, common knowledge and expert knowledge) in the definition of research problems, the definition of people concerned, and in finding solutions should be valorised...' (EIP-A, 2013: 5, 9). Designed for practitioners, its Operational Groups have been facilitating farmers' joint knowledge-production with experts, including agroecological methods (TP Organics, 2017).

4.2 Greening the CAP: productivity versus biodiversity

By contrast with that modest success in research and innovation arenas, the farmer-CSO network has had greater difficulty influencing the EU's criteria for agricultural subsidy. European agriculture has attracted a long-standing debate on its future trajectory: either to intensify cultivation methods for greater yield and global economic competitiveness, or else to extensify methods through lower external inputs for higher-quality products and biodiversity conservation. The latter trajectory depends on agroecological methods, enhancing various public goods within and beyond agriculture (Schmid et al., 2012).

Despite global pressures for trade liberalisation, the European Union maintains significant subsidy aiding agri-production through the Common Agricultural Policy (CAP) under the broad concept 'multifunctionality'. Underlying the CAP is a neo-mercantilist techno-modernist agenda seeking competitive advantage for commodity export; this agenda has shaped the CAP's pillar 1 Single Farm Payments, remunerating each farm according to its production units. In parallel pillar 2, the European Agricultural Fund for Rural Development (EAFRD), supports farmers' livelihoods in marginal, less productive areas; these have undergone economic pressures to become more market-orientated, e.g. through 'quality' products and/or agroecological methods aimed at affluent reflexive consumers (Potter and Tilzey, 2005). Tensions between those trajectories have pervaded the CAP.

In the run-up to the 2013-2020 CAP, numerous CSOs and farmers' groups formed ARC2020, an alliance bringing together progressive and radical trends of the alternative food movement. Resulting partly from their campaign, the European Commission proposed measures for 'greening' the subsidy criteria, namely: In the CAP's first pillar, Green Direct Payments must comprise at least 30% of the national budget for direct farm payments. Farmers can be remunerated for three obligatory practices – maintenance of permanent grassland, ecological focus areas and crop diversification (DG Agriculture, 2013; EC, 2013). For each farm larger than 15 hectares of arable land, 5% must be covered by Ecological Focus Areas (EFA). These are meant to bring environmental benefits, improve biodiversity and maintain attractive landscapes – such as through landscape features, buffer strips, afforested areas, fallow land, areas with nitrogen-fixing crops etc.

However, the agro-industry lobby criticised the Commission's proposals for undermining farmers' economic competitiveness. COPA-COGECA successfully lobbied the European Parliament to weaken the requirements. Consequently the EFAs have flexible criteria allowing member states and farmers to bypass or even contradict the biodiversity aim. Agronomists warned that the EFAs had weak prospects to benefit biodiversity (Pe'er et al., 2014).

Those early warnings were soon vindicated. As a wider context, catch crops are fast-growing crops grown between successive plantings of a main crop, sometimes helping to retain minerals. Some member states have favoured productive options such as catch crops and nitrogen-fixing crops, thus facilitating intensive cultivation methods rather than biodiversity. In many cases, such crops supplement chemical fertilisers rather than replace them (Lanker, 2016). Moreover, some farmers plough up semi-natural grassland, despite its importance for biodiversity (ARC 2020, 2016). Such harmful practices remain eligible within the flexible rules for subsidy.

Having advocated the reforms, an EU-wide NGO-farmer alliance then advised national campaigns how to shape and use the EU rules for a truly 'greening' agenda, especially through agroecological methods (ARC2020 et al., 2013). They jointly published a guide for how 'the new CAP can help transition EU agriculture towards agroecological approaches', linking these with food sovereignty. As the guide warned, however, their agenda conflicts with the EU's efforts at 'promoting and incentivising factory-style agriculture based on models of sustainable intensification or by simplifying the system at the expense of agroecological outcomes' (ARC2020, 2015: 1).

In those ways, the CAP encompasses divergent forms of intensification. Subsidy rewards bio-substitution methods for greater yield with lower input costs for farmers. As an implicit form of SI, these practices serve a neo-mercantilist agenda whereby agro-industrial farmers are meant to become more globally competitive. This agroecological appropriation reinforces the dominant food system. Thus a critical perspective on SI helps to illuminate conflicts over 'greening' European agriculture.

5 Conclusion: tensions of SI

Let us return to the original questions: How do agri-intensification agendas appropriate agroecological practices for reinforcing the dominant agro-food system? or else for contesting it? How do such issues arise in policy arenas, especially in Europe? through what alliances and agendas?

The term SI itself has undergone change and debate. After the 2007 global food crisis, mainstream institutions extended the original SI concept from small-scale peasant farmers to global relevance. SI was now meant to address multiple problems including food insecurity, environmental degradation and climate change, all within dominant assumptions about farmers competing on global markets through higher yield, conflated with 'productivity'. From earlier debates about sustainable agriculture, the question 'what to sustain?' has been displaced by the question 'what and how to intensify?'

Agroecological practices are niche innovations which can play various roles in relation to the incumbent agro-food regime. Such divergent roles correspond somewhat to 'stretch-transform' versus 'fit-conform' strategies (cf. Smith and Raven, 2012), as follows.

For at least a decade, agroecological practices have been promoted by alliances among farmers, civil society organisations (CSOs) and agronomists. Their agenda valorises wider public goods, partly to enhance agroecological methods themselves, based on farmers' knowledge-exchange. Their agenda links agroecology with food sovereignty for contesting and transformative the dominant agro-food regime.

More recently some agroecological methods have been selectively appropriated by the dominant regime, especially through the umbrella term sustainable intensification (SI). This is meant to raise yields with less environmental harm through a broad 'toolkit' – including agroecological methods, GM crops, no-till (optionally with herbicides), etc.. With better techniques from experts, farms would become more competitive within conventional agro-food markets, thus potentially legitimising agri-industrial products as 'green'.

In its latter prevalent role, SI can be understood by linking three theoretical perspectives, namely: A neo-productivist paradigm seeks to reconcile productivist aims with resource conservation (Marsden, 2012). The neoliberal food regime has generated a reformist agenda seeking to incorporate smallholders who would otherwise be marginalised or expelled. This agenda acknowledges that all potential solutions are needed, while narrowing them to technical options (Holt-Gimenez and Shattuck, 2011). And a nascent corporate-environmental food regime aims to alleviate environmental harm from agro-industrial systems and/or to establish distinctive 'green' production chains (Friedmann, 2005, 2009). Moreover, here those perspectives have illuminated how SI implicitly relates to European policy agendas, e.g. land sparing versus land sharing, research priorities, and agri-subsidy criteria.

Agricultural systems entail trade-offs between productivity versus sustainability, as a rationale to seek innovative methods which can minimise such trade-offs or even offer synergies. Although productivity can broadly include environmental services, in practice it is more narrowly seen as the yield of specific commodity crops, in turn attributed to specific techniques such as bio-input-

substitutes. The latter approach complements a land-sparing strategy, i.e. raising yield on some land in order to keep other land outside cultivation, e.g. for biodiversity conservation. By contrast, an agroecosystems land-sharing strategy enhances synergies between biodiversity and productivity, understood more broadly. This divergence is manifest in two European expert reports analyzed earlier.

Prevalent SI agendas involve only two components of agroecology – scientific knowledge and agronomic practices . As the third component, social movements are essential for agroecological experiments to build farmers' collective knowledge and build support for a transformative role (Wezel et al., 2009). Combining all three components, a European CSO-farmer alliance has sought policy change favouring agroecological practices within a food sovereignty perspective.

For that CSO-farmer alliance, policy arenas have had different opportunities and outcomes. They have gained greater support for their agroecological agenda in EU research and innovation priorities. But they had only modest success in the agri-subsidy 'greening' agenda, originally meant to enhance biodiversity, crucial for agroecosystem transformation. After strong lobbying from the agri-industry lobby, subsidy payments remain available for high-yield 'productive options', even if such methods supplement agrochemicals, thus fitting the dominant system.

Like other 'reformist' initiatives, SI potentially divides the progressive and radical trends of alternative food movements (cf. Holt-Gimenez and Shattuck, 2011: 133-34). Yet instead the two trends have come closer together through joint CSO-farmer policy agendas, at least in Europe. From their standpoint, the prevalent SI agenda has become suspect for subordinating agroecological methods to agro-industrial systems and conventional supply chains.

What strategic implications? From a transformative perspective on the incumbent agro-food regime, SI may seem yet another example of conventional agriculture's capacity to sustain the unsustainable (cf. Buttel, 2005, 2006). Nevertheless SI offers entry points for sharpening debate on diverse aims and forms of productivity. Agri-intensification initiatives also may offer opportunities for CSO-farmer alliances to press for agroecosystem approaches based on farmers' knowledge. These can push practices beyond the dominant neoliberal regime, even beyond 'green' corporate-environmental alternatives. By recognising different forms of intensification, alliances can develop better strategies for intervening in agri-policy arenas, regardless of whether SI is explicit.

Questions to explore:
How do some forms of agri-intensification become favoured or presumed by policy agendas?
How do the issues around SI arise in various policy contexts, explicitly or implicitly?
How do various stakeholder groups form alignments supporting or opposing specific forms of agri-intensification?
How do those alignments strengthen or marginalise efforts to transform the dominant agri-food regime?

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